ENGN 1932M: Foundations of Internet Communications Systems
Fall Term / AY23-24
Syllabus (V4)

Instructor:
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Motivation:
Communications is a fundamental part of our society and has had quite an amazing evolution over the last 100 years. We see several examples on a day-to-day basis including: HD radio, the ubiquity of wireless Mobile phones, global 4K video coverage of the Olympics, the use of Satellites to broaden the reach of the Internet and IP-Video services that deliver ubiquitous online meetings. When communication services are delivered across the Internet, it can provide a powerful impact on society. Our motivation is to understand these end-to-end systems and to motivate our Engineers to build the next generation of such systems.

Course Description:
ENGN 1932M is targeted at upper-level electrical and computer engineering concentrators and grad students who are interested in working in the world of digital communications. The course examines the foundational technologies that were developed by best engineering practices and have now become the cornerstones of the modern Internet. We will progress from basic to more advanced concepts including audio/video signal processing, transmission, TDM switching systems, packet delivery of digitized media, IP session management, broadcast/multicast networks, call control and protocol-based Cloud services. We expect to supplement many of the class lectures with the demonstration of some of the key foundational concepts. We will then look at Communications across the Internet and the popular “SaaS” model that enables most of commerce and collaboration services. Our final lecture will address the Vision for the evolving Internet and determine where there are the most interesting areas of Engineering growth.

Lectures will be supplemented by industry experts to provide more in-depth insights about topic areas, with experience in building real-time, reliable, distributed communications systems as used by the Internet today. The course will also include a series of in-class demonstrations and an opportunity for a “hands-on” learning approach including an end of semester team project.

Prerequisites:
Although the class is intended to be ‘survey’ in nature covering a variety of topics, this is not intended to be an introductory class. Students need to have a basic understanding of circuits, elementary programming, and electronic communications. We are assuming that students have decided on EE or CS and have taken at least **ENGN0030** and **ENGN0520** or equivalents. It is recommended that the student has some background with mathematics of signals (ENGN1570), digital circuits (ENGN1630) and computer networks (CSCI1680) but these are not hard requirements and can be taken in parallel with the class.

Course Outcomes:

The "learning approach" will be two-fold from the outset of the class:

1. Our primary focus is to learn about the technical and historical foundations for Communications Systems that are commonplace in society today. We will understand how digital communications has evolved for a variety of mediums and how these systems need to be developed with a real-time, end-to-end systems approach. The class will be more focused on technology and architecture and less about the mathematics of communications and there will be multiple in-class demonstrations to show how these systems perform in practice;

2. The second main outcome is to get the Brown student ready to collaborate in today's industry and to apply our baseline Engineering training to further develop the state of Communications. This includes collaborating with classmates, visiting today's technology leaders, participating with in-class demonstrations, recruiting in the hiring market, and presenting the design of a hypothetical Communications system as a capstone project. We will bring in a handful of subject matter experts from today's product leaders in the space to explain their products and what considerations they needed to consider in developing world-class and essential services for consumers.

In summary, we want the students to understand the academic side of how *Communications* are provided in society but also to "learn by doing" with hands-on experimentation.

Course Website:

All assignments unless otherwise specified should be submitted on the course Canvas website (canvas.brown.edu). All presented class materials, handouts, assigned readings and demo follow-up will be hosted on this site. Course announcements, schedules and class logistics will on the website as well and expect this site to be the main communication between staff and students throughout the semester.

Textbook(s):

There is no required textbook for this course. There will be "classic texts" that we will refer to throughout class preparation:

1. *Digital Communications,* Jarry and Beneat
2. *Digital Telephony*, Bellamy
3. *Telecommunications Transmission Handbook*, Freeman
4. *Computer Networks*, Tannenbaum
5. *Notes On The Network*, Telecordia

Articles, reading materials and HW problem sets will be provided throughout the semester.

Tentative Class Schedule:

We have structured the course material into 16 different segments and those segments will be delivered on roughly a weekly basis:

Week	Topic(s) Covered
1	Introductions, Class Logistics, Background, etc.
2	Communications Systems – A Historical Perspective
3	Why *Digital*? – Sampling of real-world signals like Voice and Video
4	Phone Communications Systems
5	Traditional Radio Networks
6	Packetized Radio and Voice
7	Networking Protocol Development
8	VoIP and Digital Telephony
9	Streaming Media Systems
10	Image Processing and Video Conferencing
11	Streaming Media Broadcast
12	(Fiber) Optical Communications Systems
13	Wireless "Wi-Fi" Systems
14	Cloud Communications Services
15	Satellite Communications
16	Vision: *Global Communications For The Future (2050)*

We will also make time for scheduled tests, field trips and other "out of class" activities such as:

- **Field Trip**: Visit to local communications company in Boston/Providence area
- **Resume Development**: How to represent your skills and interest in the market
- **Job Fair**: Participate in local job fair interviewing with and evaluating companies
- **Final Design Project**: Presenting to peers and external guests

Once the academic schedule is finalized for the course, we will schedule our expected 20+ lectures with these above events and this will all be published on our Canvas site.

Proposed Lab / Demo Topics:

There will be a series of in-class topical demonstrations with a 2-week frequency

Fortnight 1: Basics of Voice Sampling
Fortnight 2: UCaaS For Cloud Telephony Services
Fortnight 3: Wireless Communications
Fortnight 4: Video Conferencing Services
Fortnight 5: Streaming Media Services

These demos would be 20 minutes in duration and would be available for students to play with after the class session. The demo techniques are representative of what students will use to facilitate their final projects. We will plan to use tools like MATLAB and other equipment around B&H to help demonstrate concepts in communications.

Class Structure and Cadence:

- Fall Semester for AY23/24
- 1 lecture per week – Monday afternoons – 3:00-5:30 pm
- Virtual Office hours: Friday – 3:00-5:00 pm
- On-site Office hours: Tuesday – 8:30-10:00 am
- Team project coaching: scheduled throughout the semester virtually

- Guest Subject Matter Experts will join scheduled lecture hours virtually
- Field Trip, Job Fair, Resume Workshop
- Final design project

Proposed Class Grading Scheme:

We will distribute the grading for the course across the following efforts -

25% - Bi-weekly on-line HW and Quiz assignments
25% - Mid-term
40% - Final Design Project (2-person teams)
10% - Participation

We do expect homework and quizzes to be administered online through Canvas to provide some flexibility for the students in terms of learning and participating. As the final design project will be a significant percentage of the grade, we will be clear about the guidelines for the project starting right from the first few classes. We want to make sure the design areas of interesting to the students and well scoped for industry expectations.

Final Project:

In the spirit of developing our "industry skills," we will deliver a capstone design project for the last 2-3 weeks of the semester. We would expect 2-man project teams that consider the design of a communications system and to present that solution to classmates and some invited subject matter experts. In addition, we would like the teams to present the design concept and to provide a "hackathon style" demonstration for their project. We will develop a set of requirements for each project by mid-semester. The project will stress the team's design abilities but also the need to explain and demo the concepts – all great skill development.

Time Allocation and Participation:

The estimated work required in-and-out of class should total approximately 180 hours for a 15-week semester. On a weekly basis, we will spend 3 hours of class time; class preparation reading for 3 hours; homework 3 hours; online collaborative assignments 3 hours per week; in-class demonstration participation .5 hours; test/quiz prep 2 hours. As we close the semester, these hours will be replaced with a final capstone design projects which could be significant with 10 hours per week for the second half of the semester. The weekly time budget will vary week to week based on other planned class activities such as our expected field trip. We will plan to reward students that make the effort to participate in all the planned activities for the class.

Course Materials and Costs:

There will be no planned charges for additional course materials.

Academic Code Adherence:

As with all Brown classes, we would expect all students to adhere to the Brown University Academic Code . Violations of the Academic Code will lead to strict disciplinary action as outlined in the Code. Misunderstanding of the Code will not be accepted as an excuse for dishonest work.

Academic Integrity Statement:

https://www.brown.edu/sheridan/teaching-learning-resources/inclusive-teaching/academic-integrity

General Resource For Teaching and Learning:

https://www.brown.edu/sheridan/teaching-learning-resources/teaching-resources/course-design/creating-brown-university-syllabus

Course Syllabus Planning:

https://docs.google.com/document/d/1krQP-_MZQKWDEJ8BMls8uHPjVAq1ma9Sr9Aggf0_H5k/edit?usp=sharing

Check-list: ***https://docs.google.com/document/d/1krQP-_MZQKWDEJ8BMls8uHPjVAq1ma9Sr9Aggf0_H5k/edit***